RanunculaceaeCButtercup family

Clematis L.
clematis

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Growth habit, occurrence, and use. The genus *Clematis* includes more than 200 species of climbing vines, and erect or ascending perennial herbs (sometimes woody) widely that are distributed through the temperate regions, chiefly in the Northern Hemisphere (Rehder 1940). *Clematis* is subdivided into 3 sectionsCFlammula (western and eastern virgin=s-bowers), Atragene (western blue clematis and *C. occidentalis* (C.L. Hitchc.) Pringle), and Viorna (traveler=s-joy). The taxonomy and distribution of section Atragene are described by Pringle (1971). Many horticultural varieties are grown for ornamental purposes (Dirr 1990; Lloyd 1977; Markham 1935). The 8 species included here (table 1) are also useful for erosion control, ground cover, and wildlife food (Bailey 1939; Dirr 1990; Fernald 1950; Rehder 1940; Van Dersal 1938).

Species occupy different site types within their range. In Wisconsin, for example, eastern virgin=s-bower was found in 13 community types but was most abundant in the wet alder thicket community. Rock clematis is present in 2 communities and most abundant in northern dry mesic forests (Curtis 1959). Western species seem to be more common on drier well-drained sites than species native east of the Mississippi (table 1).

Geographic races. Two varieties of western virgin=s-bowerC*C. ligusticifolia* var. *californica* Wats. and var. *brevifolia* Nutt.Care separated geographically within the species= range (Vines 1960). These and a variety of eastern virgin=s-bowerC*C. virginiana* var. *missouriensis* (Rydb.) Palmer & Steyrm.Cmay be geographic races. Wild plants intermediate between Drummond clematis and western virgin=s-bower may be of hybrid origin (Vines 1960). Several hybrids of Italian clematis are known (Rehder 1940).

Flowering and fruiting. There are both monoecious and dioecious species. Eastern virgin=s-bower and western virgin=s-bower (section Flammula) are dioecious, but their female flowers have non-functional stamens. Species in the sections Atragene and Viorna are monoecious (Fernald 1950). Flower size differs significantly among species, for example, eastern virgin=s-bower flowers occur in clusters (panicles) containing several flowers, and their sepals are about 0.5 cm in diameter, whereas rock clematis flowers are borne singly, and their sepals are about 4 cm. Fruits are borne in heads of 1-seeded achenes with persistent feathery styles. Achenes (figures 1 and 2) are produced annually (Rudolf 1974) and are dispersed by wind in late summer or fall. Some species have been shown to produce viable seeds the first year after sowing (neoteny) (Beskaravainya 1977). Dates of flowering and fruiting are listed in table 2. Effects of day length and temperature on flowering and flowerbud development were reported by Goi and others (1975). Other characteristics of 8 common species are presented in table 3.

Collection of fruits and extraction and storage of seeds. Fruits are brown when ripe and may be gathered from the plants by hand, dried, and shaken to remove the seeds from the heads. Other characteristics of ripeness are when the styles have become feathery (figure 1) and the achene appears shrunken and separates easily from the head (Stribling 1986). Large quantities of fruits may be collected by means of a vacuum seed harvester, run dry through a hammermill to break up the heads, and fanned to remove debris (Plummer and others 1968).

Numbers of cleaned seeds per unit weight are listed for 7 species in table 4. Limited data for eastern virgin=s-bower, traveler=s-joy, and Italian clematis indicate that in seeds not freed from the styles, purity runs from 90 to 95% and soundness about 85% (Rafn and Son 1928; Rudolf 1974). For hammermilled seeds of western virgin=s-bower, a purity of 20% is acceptable in Utah (Plummer and others 1968) because separation of the broken styles from the seed is difficult and expensive. Viability of dry seed of this species has been maintained for 2 years without refrigeration (Plummer and others 1968).

Germination. Clematis seeds have dormant or immature embryos (Dirr 1990; Dirr and Heuser 1987). Some species and hybrids may germinate over a period of from months to years (Lloyd 1977). Dirr (1990) and Dirr and Heuser (1987) also indicate that requirements for germination vary among the taxa.

Prechilling at 1 to 5 ˚C in moist sand, peat, or a mixture of the two for 60 to 180 days has been used to promote germination in some species (Dirr and Heuser 1987; Fordham 1960; Hartmann and others 1990; Heit 1968). Field sowing responses of traveler=s-joy and Italian clematis (Blair 1959) indicate that warm plus cold stratification may be needed. The presence of an immature embryo in Italian clematis suggests that the warm stratification allows the embryo to mature, which allows germination to occur (Clark and others 1989). Germination of seeds of *Clematis microphylla* F. Muell. Ex Benth. was improved by removing the pericarp or by exposing them to a cycle of wetting and drying (Lush and others 1984). Germination of seeds of traveler=s-joy collected and sown in November was lower and germination rate lower than that of seeds collected and sown in February (Czekalski 1987).

Germination tests can be run on pretreated seed in sand flats or germinators for 40 to 60 days at 20 ˚C (night) to 30 ˚C (day) (Rudolf 1974). Test results available for 4 species are shown in table 5.

Nursery practice. Only some species are propagated from seed because of unacceptable variation in form and flowering that detracts from their value as an ornamental (Evison 1977; Lloyd 1977). The most appropriate sowing schedule is based on species and winter conditions and will vary with geographic location. General recommendations are to sow untreated seed in the fall soon after collection or to sow in the spring using seed stratified over winter (Bailey 1939). Untreated fall-sown seeds of traveler=s-joy and Italian clematis have germinated the following fall (Blair 1959). Stribling (1986) recommends the following schedule for propagating Armand clematisCC. *armandii* FranchCin central California: store seeds collected in late May in a refrigerator until September; soak in cold water for 24 hours and treat with a fungicide; stratify for up to 180 days at 1 to 5 ˚C in sealed plastic trays; sow in March or April.

Vegetative propagation is a common practice and used exclusively to propagate most of the popular species and varieties. Procedures for vegetative propagation from cuttings, grafting, and division are discussed by Dirr and Heuser (1987), Evison (1977), Lloyd (1977), and Markham

(1935).

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Figure 1—*Clematis virginiana*, eastern virgin=s-bower: 1 achene with complete style and 2 achenes with styles removed, × 4.

Figure 2—*Clematis virginiana,* eastern virgin=s-bower: longitudinal section through an achene, × 10.

Table 1C *Clematis,* clematis: nomenclature and occurrence

Scientific name & synonym(s)	Common name	Occurrence
***C. columbiana* (Nutt.) Torr. & Gray** *C. verticillaris var. columbiana (Nutt.) Gray*	**rock clematis,** mountain clematis, purple clematis	Quebec to Manitoba, S to New England, West Virginia, Ohio, Wisconsin, & NW Iowa
***C. drummondii* Torr. & Gray**	**Drummond clematis,** Texas virgin=s-bower, graybeard	Central & E Texas, Arizona & in Mexico on dry, well-drained soils
***C. flammula* L.** *C. pallasii* J. F. Gmel.	**plume clematis**	Mediterranean region to Iran
***C. ligusticifolia* Nutt.** *C. brevifolia* Howell	**western virgin=s-bower,** western clematis, traveler=s-joy	British Columbia & North Dakota S to New Mexico & California
***C. pauciflora* Nutt.**	**rope-vine**	California on dry, well-drained sites
***C. virginiana* L.** *C. catesbyana* Pursh	**eastern virgin=s-bower,** Virginia virgin=s-bower, eastern clematis	Maine to Georgia to Louisiana to Kansas in low woods & along stream banks
***C. vitalba* L.**	**traveler=s-joy,** old-man's-beard	S Europe, N Africa, & the Caucasus Mtns.
***C. viticella* L.**	**Italian clematis,** vine-bower	S Europe & W Asia

Table 2C *Clematis,* clematis: phenology of flowering and fruiting

Flowering Species	Fruit Location	dates	ripening dates
C. columbiana	C	MayBJune	JulyBAug
C. drummondii	SW US	MarBSept	AugBOct
C. flammula	C	AugBOct	AugBOct
C. ligusticifolia	California	MarBApr	MayBAug
	Texas	MarBSept	AugBNov
	Colorado, Utah	MayBAug	OctBDec
C. pauciflora	California	MarBApr	MayBJuly
C. virginiana	C	JulyBSept	JulyBSept
	Minnesota	JuneBJuly	AugBSept
C. vitalba	NE US	JulyBSept	JulyBSept
	France	JuneBJuly	SeptBOct
C. viticella	NE US	JuneBAug	JuneBAug

Sources: Fernald (1950), Loiseau (1945), McMinn (1951), Mirov and Kraebel (1939), Radford and others (1964), Rehder (1940), Rosendahl (1955), Rydberg (1922), Van Dersal (1938), Vines (1960).

Table 3C*Clematis,* clematis: size, year first cultivated, and flower color

Species	Length at maturity (m)	Year first cultivated	Flower color
C. columbiana	2.8	1797	Purple
C. drummondii	C	C	White
C. flammula	3.1B4.6	1509	White
C. ligusticifolia	0.9B12.3	1880	White
C. pauciflora	C	Before 1935	White
C. virginiana	3.7B6.2	1726	Creamy white
C. vitalba	10.2	Long cultivated	White
C. viticella	4.6	1597	Purplish

Sources: Fernald (1950), McMinn (1951), Rehder (1940), Rosendahl (1955), Vines (1960).

Table 4B*Clematis,* clematis: seed yield data

Species	Place collected	No. cleaned seeds/seed weight Range /kg	Range /lb	Average /kg	Average /lb
C. columbiana	Minnesota	C	C	141,440	64,0001
C. flammula	Europe	C	C	55,250	25,0001
C. ligusticifolia	California	C	C	205,530	93,0001
Utah	663,000B724,880*	300,000B328,000*	696,150*	315,0003*	
C. pauciflora	California	C	C	187,850	85,0001
C. virginiana	Baraga Co., Michigan	402,220B446,420	182,000B202,000	424,320	192,0001
C. vitalba	Europe	C	C	707,200H	320,0001
C. viticella	Europe	48,620-103-870	22,000-47,000	59,670	27,0003

Sources: Mirov and Kraebel (1939), Rafn and Son (1928), Rudolf (1974).

* Styles removed.

H Styles presumably removed.

Table 5C *Clematis,* clematis: germination test results on stratified seeds

Species	Test duration (days)	Germination capacity (%)	No. of tests
C. drummondii	40	76	1
C. ligusticifolia	200	11B84	8
C. pauciflora	C	36	1
C. virginiana	60	32	1

Sources: Mirov and Kraebel (1939), Plummer and others (1968), Rudolf (1974), Swingle (1939).